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Transceiver Test Plan

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May 1979, Sections 2 through 5

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I. Introduction

This document represents the results of meetings with representatives of the U.S. Coast Guard and contacts with the U.S. Fire Administration to identify the requirements for the operational testing of the Firefighters Communication Transceiver. The major concerns of the firefighters and U.S. Coast Guard Strike Team members centered around the integrity and reliability of the firefighter/microphone interface. The technical characteristics of the radio itself were of less concern. The major concern about the radio hardware was that it be intrinsically safe in hazardous atmospheres. Another major concern voiced by Lt. Glenn of the Coast Guard Atlantic Strike Team was that the system not interfere with the fit or facial seal of self-contained breathing apparatus (SCBA).

The single greatest concern for operational testing purposes was the reliability and clarity of the line of communication between the firefighter and those on the fireground with whom he must maintain contact. All individuals interviewed cited several examples of the respective shortcomings of existing microphone subsystems. An overall preference for the currently available for the throat contact microphone was tempered by the need to use tape or VELCRO neck bands to keep the microphone positively secured against the throat. The Coast Guard Team members felt they would make the best judges of the operational effectiveness of the final radio design. The Team stated a desire to test any units developed in both training exercises and in real responses to hazardous material incidents. Coast Guard Strike Team members felt that a VOX-microphone built into the SCBA facemask would provide the best performance. Short of this, the Team members expressed a desire to see a better throat microphone that remained in place in spite of sweating and without the need for taping or strapping. One new voice-pickup product of

particular interest is the "Earmic" available from KAVCO Industries of California and TAD America in Hawaii. This device combines a bone conduction microphone and a speaker into a single ear-mounted unit. The TAD America device is certified as intrinsically safe and KAVCO Industries is contemplating development of a VOX version of their "Earmic." The KAVCO product is currently seeing successful use by the Huntington Beach, California Fire Department.

II. Background

A "breadboard" version of a portable fireground radio has been developed by REMIC Corporation to demonstrate the feasibility of producing a low-cost, reliable, fireground communication system. The fireground radio was conceived to provide the individual firefighter with automatic hands-free communications between himself and his associates and his captain. The hands-free operation of the radio is the major design requirement. Waterproof construction, light weight, ease of operation, and reliable maintenance of the line of communication are other design objectives for the unit. The fireman's need to have both hands free to carry out mission activities and provide for his personal safety is clear cut. Securing a high level of firefighter confidence in hands-free operation of the fireground radio will require very high reliability in the voice-actuated microphone subsystem of the unit. Current portable fireground radio units employ throat contact microphones (see Figure 1), boom microphones, or bone conduction microphones when self-contained breathing apparatus (SCBA) are worn. Problems with these alternative microphone systems vary from the throat microphone slipping out of position to boom microphone activation by loud external sources of sound, and other unique problems with the conduction microphone. Improved design of the contact and conduction microphones or replacement is necessary if the operational effectiveness of

the Firefighter's Communication System is to meet the stated requirements of the firefighting population for whom it is targeted.

Among the human factors constraints placed on the communication system's radio unit is its placement on the body of the wearer. The radio is to be located inside the outermost layer of protective clothing. This means inside the turnout coat of the firefighter and inside the outergarment (see Figures 1 and 2) of the U. S. Coast Guard's totally encapsulating Hazardous Chemical Protective Ensemble (HCPE). Any vests, harnesses, or supporting straps must compete for space with similar elements used for SCBA or found with inner garments. The radio unit itself may compete with air hoses or cooling garment components (e.g., the ice pouch) in the case of the Coast Guard's fully encapsulated suit (see Figures 2 and 3). Potential sites suggested by U.S. Coast Guard Atlantic Strike Team members in order of preference include high on the centerline of the chest in the area of the sternum, low on the front ribs, and on the side of the thigh. Crowding was given as the reason for not preferring a head mounted unit in the presence of SCBA and helmet straps.

III. Testing the Fireground Radio Communication System

The testing of the Fireground Communication System is divided into two parts. One test series is established to measure device performance under controlled laboratory conditions. The principal protocol for this test series is taken from an Electronic Industries Association Recommended Standard for portable/personal communication FM or PM equipment operating between 25-1000 MHz. Other subsystem specific tests will be proposed for different items that make up the fireground radio. The second test series is based on the actual use of the radio units by firefighting/strike force teams initially engaged in training exercises and ultimately engaged in live responses to fireground or hazardous material incidents. The vehicles for conducting the

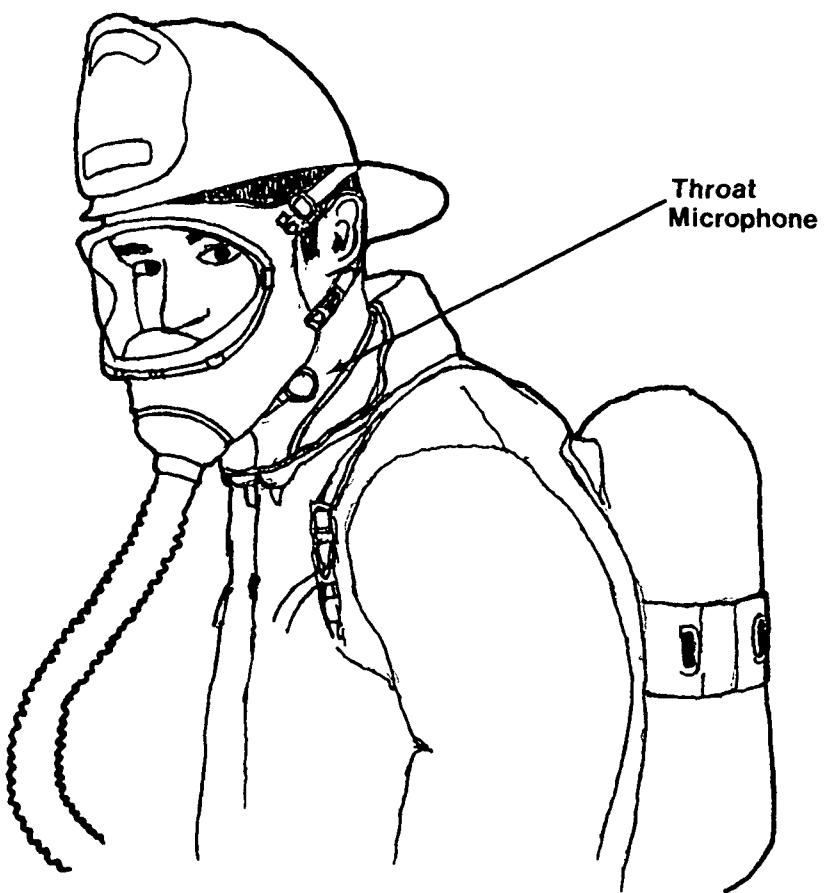


FIGURE 1 - THROAT MICROPHONE/SELF-CONTAINED BREATHING APPARATUS COMBINATION

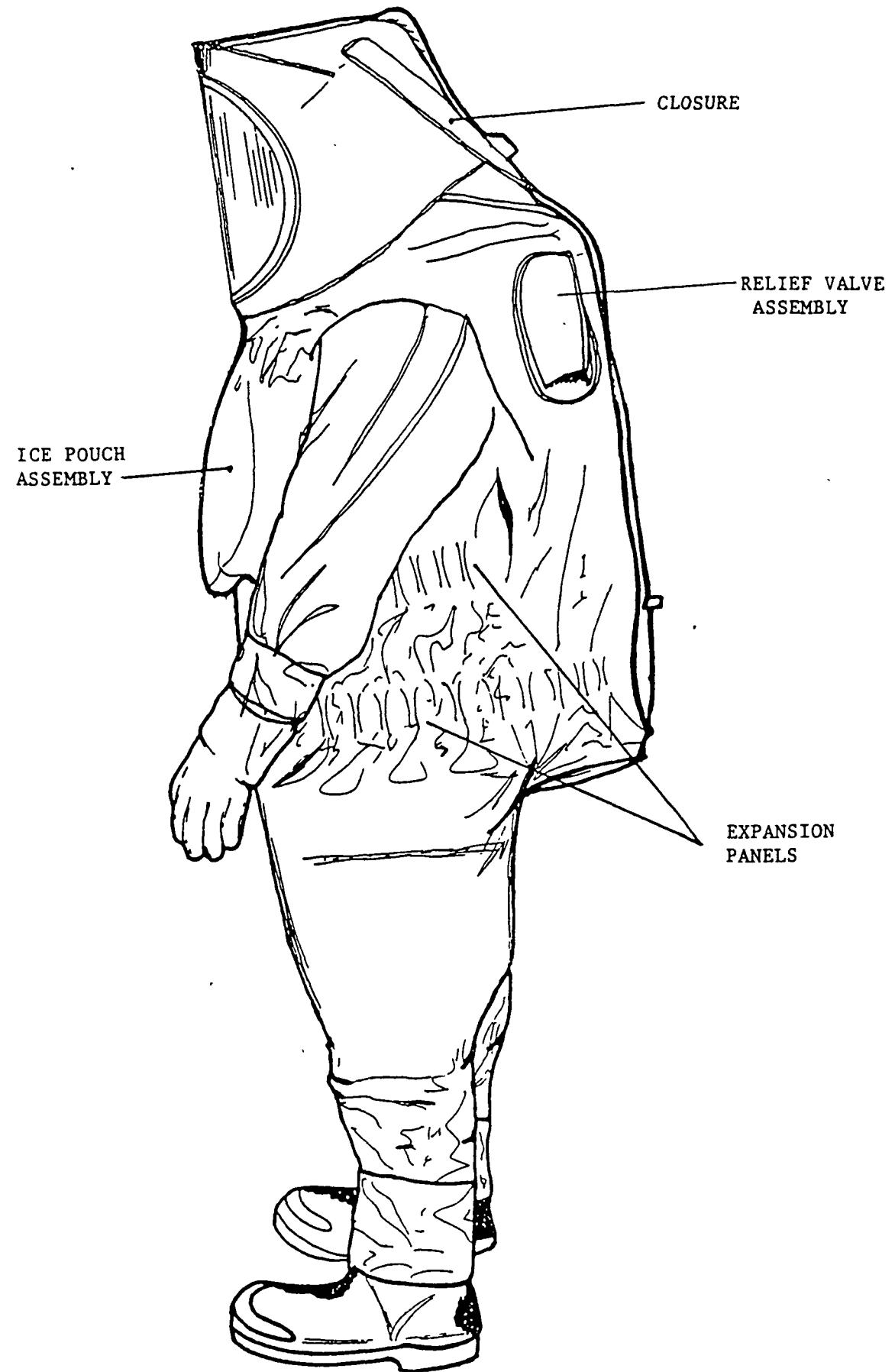


FIGURE 2 - OUTERGARMENT DESIGN CONFIGURATION

BACK

COOLING GARMENT

FRONT

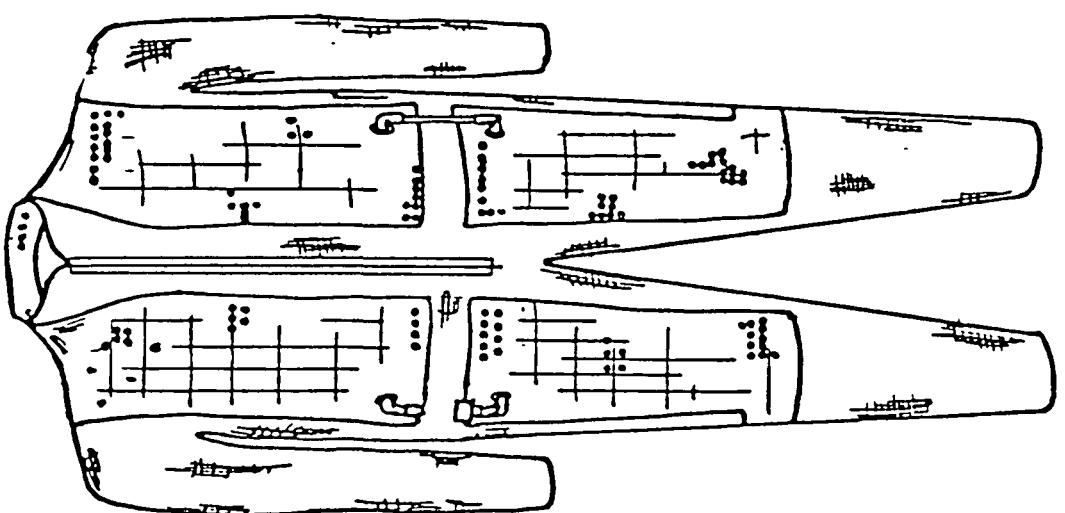
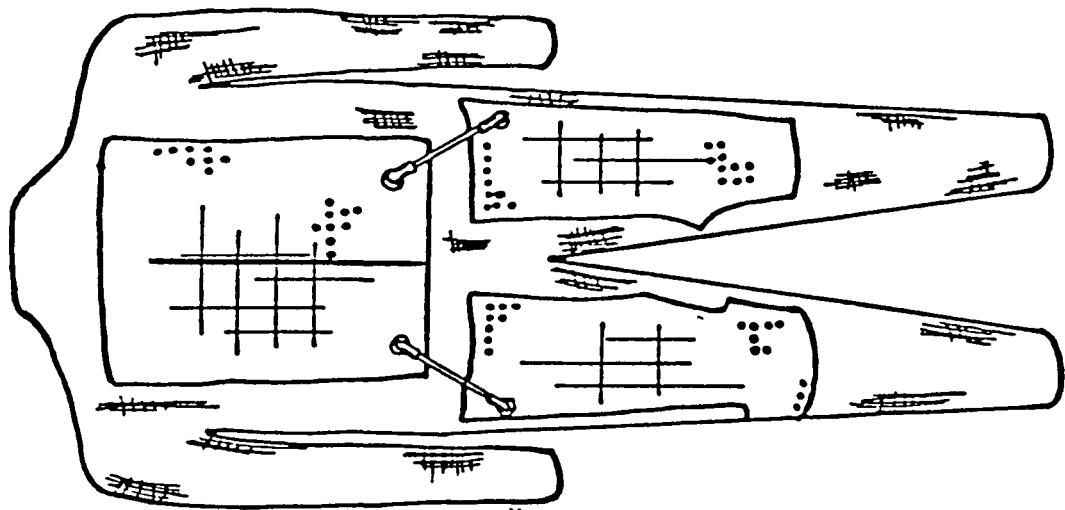


FIGURE 3 - COOLING GARMENT USED IN CONJUNCTION WITH TOTALLY
ENCAPSULATED HCPE.

field-based tests are an annotated communication log and a survey questionnaire filled out by participating members of fireground test teams. The details of the field test communication log and survey questionnaire will be covered in a later section of this report. The following section represents a general approach for the controlled laboratory testing of the firefighter's transceiver.

IV. Controlled Laboratory Testing of the Device

For the purposes of the Firefighters' Communication Transceiver Test Series, the scope and definition of the portable communications equipment is taken to be that of EIA Standard RS-316-B (Revision of RS-316-A) May 1979.

"1.1 Scope--This standard details the minimum performance requirements for portable/personal communicaton FM or PM equipments as defined in paragraph 1.2, except temperature operating range of the power source shall not be included. It excludes accessories like chargers, power boosters, batteries, etc.

1.2 Definition--Portable/personal communications equipment are radio transmitters, receivers, or combinatons of both, which can be hand-carried or worn on the person, and which are operated from their own portable power sources and antenna. Personal equipment is further defined as that which is capable of being worn directly on the person or within the clothing (e.g., surveillance or paging equipments) and is, therefore, subject to less severe environments than other classifications of portable equipment."

"Minimum Standards for Portable/Personal Radio Transmitters, Receivers, and Transmitter/Receiver Combination Land Mobile Communications FM or PM Equipment, 25-1000 MHz"

Also adopted for the controlled testing of the Firefighters' Communication Transceiver hardware are the paragraphs and subparagraphs of EIA Standard RS-316-B. An outline of EIA Standard RS-316-B, Sections 2-5 is included in this report as Appendix A.

The prototype radio assemblies developed under this program should be tested using widely recognized standards for testing portable/personnel land mobile radios. Most of the technical performance characteristics of the radio will be tested in a laboratory setting in the first phase. These technical characteristics are more or less covered by various available standards. Some examples of standards or organizations whose standards have been used to evaluate portable UHF transceivers similar to the fireground radio are presented in Table 1 below.

Table 1
Standards Which Have Been Used To Test Portable
UHF Transceivers and Transceiver Subsystems

<u>TRANSCEIVER/SUBSYSTEM TEST FUNCTION</u>	<u>ORGANIZATION/STANDARD</u>
1. Transmitter/Receiver Combination Performance	EIA Standard RS-316-B May 1979
2. Battery Pack/Internal Components intrinsic safety	a) Factory Mutual Research Corporation, "Intrinsically Safe Apparatus and Associated Apparatus for Class 1, Division 1, Hazardous Locations b) NFPA Standard 493
3. Radio/Battery Pack shock and vibration resistance	EIA Standard RS-316-B May 1979
4. Radio/Battery Pack weather proofing	MIL STD 810-C (Driven rain test)
5. Rechargeable Battery Pack performance	United Laboratories

The Firefighters' Communication System and Subsystem tests identified by this minimum set of standards are to be superceded by more extreme fireground requirements where ever greater performance was called for in the list of desirable radio characteristics. Examples of more extreme requirements include:

1. Temperature extremes found inside the turnout coat or fully encapsulated suit vs standard temperature.
2. Full waterproof testing vs standard humidity.

The complete version of EIA Standard RS-316-B is incorporated by reference as part of the controlled laboratory testing of the Fireground Communications System Device. The standard is available from the EIA at the following address:

Electronic Industries Association
Engineering Department
Standards Sales Office
2001 I Street, N.W.
Washington, D.C. 20006
Phone: (202) 457-4966

The test methods used to execute the test plan will be those explicitly identified in EIA Standard RS-316-B or the other recognized methods identified for the qualification testing of 450-512 MHz land mobile transmitter/receiver combinations. Alternative test methods can be used when it can be shown that excessive costs will be incurred in providing the test apparatus needed for the test method identified. If a test method can be developed and shown to be more suitable than the method specified in this test plan it may be substituted as an alternative test method upon the written approval of NASA.

To gauge the variability in the capacity of fabricated Fireground Radios to meet or exceed stated performance specifications it is recommended than ten (10) units be put through the same battery of controlled laboratory tests. The standard deviations for the measured properties will provide useful information on the repeatability in device fabrication techniques.

V. Testing the Intrinsic Electrical Safety of the Device

A major test procedure to be applied to the Firefighters' Communication System device is the test for the intrinsic safety of the device under National Fire Protection Association (NFPA) Standard 493. NFPA Standard 493 establishes the "Standard for Intrinsically Safe Apparatus and Associated Apparatus for use in Class I, II, and III, Division 1 Hazardous Locations." Classes I, II, and III represent degrees of hazard for locations under the National Electrical Code. Hazardous location Class I is the most dangerous. New Firefighters' Communications System devices must be shown to provide at a minimum the same intrinsically safe quality of portable communication devices currently in use. Current U.S. Coast Guard portable/personal transmitter/receiver combinations carry a label stating that the devices are "Intrinsically Safe for Class I, Division 1, Groups C & D."

The U.S. Coast Guard need for intrinsic safety in their portable/personal transceivers follows from the dangers of explosive atmospheres often produced by hazardous materials incidents. Lower explosive limit (LEL) and permissible explosive limit (PEL) for various hazardous materials is used by the Coast Guard in determining a response to a hazardous material incident. Another Coast Guard measure of hazardous atmospheres is the determination of "Immediate Danger to Life and Health (IDLH)." In the presence of this type of atmosphere, self-contained breathing apparatus (SCBA) and fully encapsulated

suits are donned to protect the guardsman. Such situations require a continuous positive facepiece-to-face seal for the SCBA. Any microphone subsystem, whether contact or bone conduction, must never cause or contribute to a break in the facepiece-to-face seal or in a break in the closure of the fully encapsulated suit.

VI. Operational Testing Critical Issues

The Operational Testing of the Fireground Radio Communication System will be divided into six broad types of critical test issues. Effective treatment of these issues will provide a thorough coverage of all areas of concern to the firefighter or the strike team member. The six types of critical issues include:

1. Mission performance
2. Human factors, safety, health
3. Survivability
4. Reliability, availability, maintainability
5. Training
6. Interoperability

Table 2 lists the six types of critical issues along with associated sets of performance attributes and the criteria for measuring the issues.

Table 2. Critical Operational Test Issues

Critical Issues	Performance Descriptor	Criteria for Measuring the Issue	Test Method
I. Mission Performance	Communications Range	Shall operate satisfactorily up to 600 meters (1950 ft) under relatively unimpeded conditions and shall also be capable of reliable performance within a 10 story steel/concrete building structure.	Laboratory and field evaluation
	Three-mode operation - Voice-actuated (VOX) - Push-to-talk (PTT) - Receive only	Unit shall operate successfully in each mode with sidetone verification of user voice transmissions in PTT and VOX modes	Recorded observation on survey questionnaire by operating personnel
	Receiver sensitivity	< 1 microvolt at antenna terminal (~ 20 dB quieting)	Laboratory evaluation
	Communications channels	6 frequencies at the 450-470 MHz UHF band	Observation
	Transmission/reception clarity at frequencies within band	Received communications shall be loud and clear under relatively unimpeded conditions, and signal margin/antenna coverage shall be sufficient to provide 95% probability of intelligible reception of any 5 second voice message transmission	Recorded observations by fireground communications aide on communications log
	Communications coverage	Coverage shall be omni-directional for the entire frequency band of operation.	Laboratory evaluation
			(Con't)

NOTE:

Several early requirements for a Communications System targeted for integration with the Firefighters' Integrated Response Equipment System (FIRES) have not appeared in the "breadboard" fireground radio assemblies and so have not been included as operational test items. These include: 1) a high/normal power mode switch, 2) an emergency warning tone, and 3) remote activate functions.

Table 2. Critical Operational Test Issues (Con't).

Critical Issues	Performance Attribute Descriptor	Criteria for Measuring the Issue	Test Method
2. Human factors, safety, health	Radiation hazard to wearer	Radiated field intensity from the antenna shall meet personnel hazard requirements of USAS C95.1	Instrumented manikin
	Interference with physical motions	Shall not restrict outfitted firefighter's physical motions	Laboratory and field evaluation
	Physical interference with protective equipment	Shall not restrict closure of or bind articles of protective equipment	Laboratory and field evaluation
	Physical interference with breathing apparatus	Shall not impact the mask-to-face seal of breathing apparatus	Laboratory and field evaluation
	Acceptance	Fireground radio shall be acceptable and promote usage	Field evaluation and fireground personnel testimonials
	Size	Shall occupy minimum volume under turnout coat or fully encapsulated suit	Tape measurement
	Weight	Weigh less than 0.75 Kg (1.5 lbs.)	Weigh with balance
	Controls placement	Controls shall be placed so that they are operable by hand inside the protective outer garment.	Field evaluation
	Controls operability	Volume and push-to-talk operable with heavy gloves; no external connections shall be required to operate equipment	Field evaluation

(Con't)

Table 2. Critical Operational Test Issues (Con't)

Critical Issues	Performance Attribute Descriptor	Criteria for Measuring the Issue	Test Method
2. Human factors, safety, health (con't)	<p>Don/Doff time</p> <p>Mobility</p> <p>Fit</p> <p>Bodily injury</p>	<p>Don or doff time in seconds to be determined</p> <p>Fully suited subject shall be able to climb, reach, twist, crawl using both hands</p> <p>Complete system and especially microphone and/or voice pickup technology must fit all sizes</p> <p>External controls and protrusions shall be designed to preclude personnel injury.</p>	<p>Field evaluation</p> <p>Field evaluation</p> <p>Visual examination and tape measurement per ANSI Z89.3</p> <p>Field evaluation</p>

(Con't)

Table 2. Critical Operational Test Issues (Con't)

Critical Issues	Performance Attribute Descriptor	Criteria for Measuring the Issue	Test Method
3. Survivability	Exposure	Protection provided by outer garments	Field evaluation
	Durability	Years of service life to be determined	Field evaluation
	Waterproof	Survives immersion for 5 minutes in 82°C and 1°C water	Shower (driven rain, test), environmental chamber configured for moisture condensation on radio unit.
	Heat and smoke resistance	Equal to human levels	Unit mounted on instrumented manikin and exposed to heat and smoke generators in environmental chamber
	Shock and vibration	Survive 12 foot drop to concrete surface	Standard drop test
	Physical abuse resistance	Unit accepts normal fire ground impacts and handling	Field evaluation
			(Con't)

Table 2. Critical Operational Test Issues (Con't)

Critical Issues	Performance Attribute Descriptor	Criteria for Measuring the Issue	Test Method
4. Reliability, availability, maintainability	Mean time between failures - Battery pack - Actuation elements Voice-actuation Push-to-talk Receive-only - Antenna - Wires - Connectors	Meet all performance requirements throughout service life	Field evaluation equipment maintenance log
	Continuous operation from battery power supply	At least 2 hours from full charge assuming a 10% transmit 10% receive, 80% standby duty cycle	Laboratory and field evaluation
	Ancillary hardware replacement repair	Basic replacement repairs (e.g., battery, antenna, microphone) can be performed at ground base	Field evaluation
	Retention	Complete system and especially the microphone and/or voice pick up technology must remain in place throughout period of activity on fireground	Field evaluation and observation of non-retention by outfitted test subjects
	Line-of-communications	Loss of the line-of-communication with personnel on the fireground shall not be due to a failure of the fireground radio equipment with particular emphasis on the voice-pickup technology subsystem, the battery subsystems, the radio controls subsystems, and the antenna subsystem.	Fireground command post communications log and post-incident observations recorded on survey questionnaire by fireground entry personnel

Table 2. Critical Operational Test Issues (Con't)

Critical Issues	Performance Attribute Descriptor	Criteria for Measuring the Issue	Test Method
4. Reliability, availability, maintainability (Con't)	Ease of maintenance	Positive seal on switches and controls	Standard testing methods for sealed switches

(Con't)

Table 2. Critical Operational Test Issues (Con't)

Critical Issues	Performance Attribute Descriptor	Criteria for Measuring the Issue	Test Method
5. Training	<ul style="list-style-type: none"> - Operator's manual - Training time 	<p>A radio operator's manual shall be prepared to accompany the fireground radio set</p> <p>Training in the operation of the fireground radio shall be compatible with existing portable radio operation and require a minimum of training</p>	<p>Observation</p> <p>Field evaluation</p>

(Con't)

Table 2. Critical Operational Test Issues (Con't)

Critical Issues	Performance Attribute Descriptor	Criteria for Measuring the Issue	Test Method
6. Interoperability	<ul style="list-style-type: none"> · Noninterference with SCBA · Noninterference with protective firefighting ensemble · Compatibility 	<ul style="list-style-type: none"> Must not interfere or contribute to the breaking of the mask-to-face seal of SCBA Must not compromise the mobility or function provided by protective firefighting ensemble Must be compatible with existing and near term planned systems and subsystems 	<ul style="list-style-type: none"> Laboratory and field evaluation Laboratory and field evaluation Observation during field evaluation

VII. Field Tests of the Fireground Communication System

The operational testing of the Fireground Communication System in the field will entail the use of two test documents, an annotated communications log and the post-incident survey questionnaire. The communications log will be maintained by the communications aide(s) to the overall incident commander. The communications aide in conjunction with front-line personnel will coordinate for the pre-donning checkout of radio units during the breakout of equipment. The pre-donning checkout consists of a check test of all fireground radio controls, switches, indicators, and connectors. The radio elements to be tested include:

1. Antenna connection
2. Battery connection
3. Battery light
4. Busy lamp
5. Channel selection switch (6 settings)
6. Power/volume switch
7. Receiver squelch
8. Mode selection switch (3 settings)
9. Speakers
10. Microphone connection
11. Microphone(s)

Simple voice transmit and receive tests will be conducted between pairs of radio units as part of pre-donning checkout. Any malfunctioning radio will be replaced by a working unit and the identification and apparent source of the unit's malfunction will be recorded and later verified. A running log of modes of failure will be maintained through the operational field testing. The results of the malfunction log will be tabulated and used to identify areas of unacceptable subsystem performance.

The resources used to execute the operational field tests include the response team personnel, the firefighters protective ensemble (including fully encapsulated suits where called for), six to ten fireground radio units,

self-contained breathing apparatus, and all appropriate supporting equipment (i.e. ladders, hoses, hand tools, fire suppression equipment, etc.). The response team is divided between the members of a command post and the fire-ground personnel.

The members of the command post includes the overall incident commander, sector officers, (responsible for specific areas of the fireground or specific fire ground functions) and aides. If small response teams are used for operational testing of the fireground radio the overall incident commander (i.e. fireground commander, site safety officer, local on-scene coordinator) will be directly in the communications test loop. This commander is supported by a communications aide who logs the voice transactions involved in the operational test. If a large response team and up to ten (10) radios are involved in the test the commander may delegate communications responsibilities wholly to sector officers. A large test team may require an additional assistant to share the work load of the communications aide. The minimum field test team should consist of six people, two (2) fireground entry people, two (2) backups for the entry pair, one commander or officer, and one communications aide. Each test team member is provided with a radio unit. In both training exercises and real incident scenarios different functional communications modes are allocated among the channels available. Standard fire ground communications procedures and scripts will be prepared for each functional communications mode, for example ladder company communications vs rescue company or hazarouds materials team communications. Local department custom will determine the specific format of messages and responses between front-line firefighters, between firefighters and command posts, and between firefighters and fire suppression apparatus personnel. Development of communications procedures will be the responsibility of the communications

officer who would also select the operators for each of the frequencies used in an exercise or incident. Among the procedures that must be established as part of the test exercise are:

- 1) Procedures for operation on the channels available,
- 2) Procedures for testing the fire ground communications readiness of the front-line personnel,
- 3) Procedures for logging the time and contents of communications,
- 4) Procedures for logging the status and location of committed personnel and equipment.

The operational field test protocol consists essentially of recording observations of the availability and clarity of communications over the course of an incident response. In both training exercises and real incident responses the necessary additional communications monitoring personnel must be provided by the fire department or Coast Guard strike team. The communications aide and any assistants will record a running log of fire ground communications using the format or a similar format to that in Figure 4. The first page of the field test communications log contains a header section for recording the identifying characteristics of a given test. This includes entries for the test number, test scenario and location, and the makeup of the communications test team. The rest of the body of the log form and subsequent pages of the log includes entries for the time and durations of communications, the channel used, the radio unit or team member called or calling, a message code number or summary, and indications of loud/weak and clear/distorted communications. While the communications environment for any given field exercise or live incident may produce conditions that outstrip the capabilities of the proposed firefighters communication system a general goal for transmission/reception clarity as stated in Table 2 is a 95% probability

FIREGROUND RADIO FIELD TEST
COMMAND POST RADIO COMMUNICATIONS LOG

1. TEST NO. _____ 2. DATE _____ 3. RECORDER'S NAME _____
4. TEST SCENARIO & LOCATION _____ PAGE NO. _____

5a. COMMAND POST COMMUNICATIONS TEAM MAKEUP:

Role Name(s) FG Radio Unit No.

Overall Incident Commander
Communications Officer
Communications Aide
Communications Aide

58 E1BEB GROUND COMMUNICATIONS TEAM MEMBER:

3

NOTES:

FIGURE 4. INITIAL PAGE OF FIELD TEST COMMUNICATIONS LOG

of intelligible reception of any 5 second voice message transmission. This degree of satisfactory reception can be verified by tabulating the proportion of clear communications recorded in the Command Post Radio Communications Log. Communications which are too weak to be intelligible will be recorded as being distorted.

Calling and answering procedures will be established by the communications officer in preparation for a field test. Typical communications included in the field test would be test transmissions and radio checks. To establish a communications link the calling party might proceed as follows:

- a. The caller listens to make sure that the calling frequency is not busy. When not busy, the caller turns on the transmitter and should say:

"(Unit or Firefighter Called), THIS IS
(Name or unit number of calling party),
OVER"

- b. The reply to the initial call should be:

"(Name of calling party), THIS IS
(Name or unit number of answering party),
OVER"

If the calling frequency is different from the working frequency the initial calling party will request the called part to SHIFT to the working frequency. Once communication is reestablished on the working frequency the calling part can transmit a formal message.

c. The message transmission, which omits the name of the party called, should be:

"THIS IS, (Name or unit number of calling party),
(The message), OVER"

d. After receiving the transmission, the called party replies:

"THIS IS, (Name of party called),
(The response to the message),
OVER"

e. A further response is made if necessary, otherwise the transmission is concluded as follows:

"THIS IS, (Name or unit number of calling party), OUT"

f. The called party will also conclude with:

"THIS IS, (Name or unit number of called party), OUT."

If a test transmission is to be performed, the transmitting party first listens to make certain that the frequency on which the test is to be made is not busy. Usually permission is obtained prior to making a test.

g. Permission to make a test is obtained by saying:

"THIS IS, (Name or unit number of party testing),
TEST"

h. If the reply "WAIT" is not received from the answering party, the party testing may proceed with the test by saying:

"THIS IS (Name or unit number of party testing), TESTING, (A number count or other phraseology which will not confuse listeners and of not more than 10 seconds duration), (Name or unit number of party testing), (Location and if appropriate, status, of the testing party at the time the test is made), OUT"

In addition to transmission field tests another major communications test performed frequently during field exercises and live incidents is the radio check. Requests for radio checks are made directly to each specific fireground radio unit. The party requesting the radio check first establishes communications as indicated above.

i. After properly establishing contact, the calling party should say:

"HOW DO YOU HEAR ME?"

j. The proper response to the radio check request is as follows:

"I HEAR YOU LOUD AND CLEAR," or
"I HEAR YOU WEAK BUT CLEAR," or
"YOU ARE LOUD BUT DISTORTED," etc.

This procedure is repeated for all radio units operating under various conditions and at different locations on the fireground to determine the operational performance of the communications system in actual use. Simple radio check type messages like those indicated above can be used or more detailed observations of fireground radio performance can be used for the message traffic between firefighters and the communications personnel in the

command post. In all field tests the major burden for observing and recording the presence and quality of clear lines of communication will fall on command post personnel. Adequate numbers of recorders and procedures for allocating transmission and reception traffic among the recorders must be provided.

VIII. Post-Incident Survey Questionnaire

It is inevitable that some if not many of the field test events that represent failures of the fireground radio system will not be captured and recorded through messages to communications personnel at the command post. In order to obtain the additional observations of the personnel actively engaged in hazardous material or firefighting activities a post-incident survey questionnaire will be used. The questionnaire will contain items that correspond directly to the critical operational test issues included in Table 2 of this report. The questionnaire will be administered to all fireground personnel that were supplied with a fireground radio for use in either a field training exercise or a live incident. The questionnaire will at a minimum provide for the following types of questions:

Mission Performance

- 1) Did your radio transmit and receive satisfactorily up to the 600 meter range limit under relatively unimpeded conditions?
- 2) If operated in a steel/concrete building structure did your radio perform reliably at up to a 10-story separation between you and another radio unit?
- 3) What conditions did you find that seriously degraded the range of satisfactory communications?

- 4) Did your radio unit operate successfully in all three available modes: voice-actuated; push-to-talk; receive only?
- 5) Was your voice transmission verified in the PTT and VOX modes by a clear sidetone signal?
- 6) Did all six (6) channels available on your radio operate properly?
- 7) Were received communications loud and clear under relatively unimpeded conditions for the stated range of the radio unit?
- 8) In your estimate what was the percentage of intelligible receptions out of all receptions received by you?
- 9) In general, did the radio unit perform up to the level that you expected from what you were told? If it did not, why not?
- 10) What are your dissatisfactions with the radio, if any, in terms of mission performance?

Human Factors, Safety, Health

- 11) Did the method for wearing the various elements of the radio restrict your physical motions?
- 12) Did the method for wearing the radio interfere with other necessary protective garments or equipment?
- 13) Did the method for wearing the radio interfere with the mask-to-face seal of breathing apparatus?
- 14) Are the controls of the radio placed so that you can operate them by hand inside your protective outer garment?

- 15) Are the volume and push-to-talk controls operable with heavy gloves?
- 16) Are don and doff times for the radio system sufficiently short?
- 17) When fully outfitted and wearing the radio were you able to climb, reach, twist and crawl using both hands?
- 18) Did you ever find that you were at risk of personal injury due to the protrusion of the external controls or other external parts of the radio?
- 19) What are your dissatisfactions with the radio, if any, in terms of human factors, safety, and health?

Survivability

- 20) Did the manner in which the radio is worn ever expose the unit directly to destructive fireground elements?
- 21) Have you developed any impressions of the durability of the fireground radio? If so what are they?
- 22) Have you found that the radio unit accepts normal fireground impacts and handling while continuing to operate normally?
- 23) What are your dissatisfactions with the radio, if any, in terms of survivability?

Reliability, Availability, Maintainability

- 24) What has been your experience as to the reliability of major radio parts such as:
 - a) the battery pack
 - b) the controls and activation elements

- c) the antennas
- d) wires
- e) connectors?

25) Did you find that the battery power supply gave you at least 2 hours continuous operation from full charge?

26) Did the complete radio system and especially the microphone and/or voice pick up elements of the radio remain in place providing a positive line of communications throughout your period of activity on the fireground? If not explain the causes of the problem in detail?

27) Did a failure in any of the following radio subsystems cause a loss of a line of communication during your period of activity on the fireground:

- a) voice pickup
- b) battery
- c) radio controls
- d) antenna?

28) What are your dissatisfactions with the radio, if, any in terms of reliability, availability, and maintainability?

Training

29) Is the operator's manual clearly written and easy to understand?

30) Is the operation of the fireground radio compatible with existing portable radio operating procedures?

Interoperability

- 31) Did you find that the fireground radio could be operated satisfactorily in conjunction with the rest of the protective firefighting ensemble?
- 32) In your opinion is the fireground radio compatible with existing and near-term planned firefighting/hazardous material systems and subsystems? If not please explain.
- 33) What are your dissatisfactions with the radio, if any, in terms of interoperability?

IX. Conclusions and Recommendations for Field Test Implementation

Interviews with firefighting professionals and members of the Atlantic Strike Team of the U. S. Coast Guard National Strike Force have identified the key issues of concern for the operational field testing of the Firefighters' Communication Transceiver. The key test issues in order of priority are:

- 1) The verification of the intrinsic safety of the radio
- 2) The non-interference of the radio with facemasks and breathing apparatus
- 3) Very high availability of a clear line of communications to other radio units (this is considered to be primarily a function of the reliability of the voice/microphone interface)
- 4) Reliable hands free operation
- 5) Human factors performance of the radio in terms of ease of operation, security of control settings from accidental switching, compact size, light weight, etc.
- 6) Technical performance of the radio in terms of range, noise suppression, power levels, etc.

The intrinsic safety and technical performance of the radio are best tested using appropriate published standards under controlled laboratory conditions. The radio features that impact the firefighter's confidence in having a reliable line of communications during his time on the fireground are best tested during training exercises and ultimately during live incidents. Two recording documents have been identified as providing the necessary vehicles for documenting the field performance of the firefighter's communication transceiver. The first is a communications log for recording all communications that occur during a field test with provisions for recording observations on the reliability and quality of the lines of communication. The second recording document is a post-incident survey questionnaire which is completed by all fireground personnel assigned a fireground radio in the course of a field test. The results of the questionnaire are evaluated to identify elements of the Firefighters' Communication Transceiver which will require further improvements.

Comments made by many of the individuals contacted indicated there is great interest among fire departments and the Coast Guard Strike Teams in field testing an improved fireground radio. There should be no problem in finding groups to participate in the implementation of the Firefighters' Communication Transceiver field test.

APPENDIX A

Outline of EIA Standard RS-316-B May 1979

Sections 2 through 5

Minimum Standards for Portable/Personal Radio Transmitters,
Receivers, and Transmitter/Receiver Combination Land Mobile
Communications FM or PM Equipment, 25-1000 MHz

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	<u>STANDARD</u>
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2.1 Definition	1
2.2 Specific Standard Test Conditions	1
2.2.1 Standard Temperature, Relative Humidity and Barometric Pressure	1
2.2.2 Standard Test Modulation	1
2.2.3 Rated System Deviation	1
2.2.4 Standard Test Voltage	2
2.2.5 Standard RF Signal Sources	2
2.2.5.1 Standard Integral RF Signal Sources	2
2.2.5.2 Standard External RF Signal Sources	2
2.2.6 Standard Audio Input Signal Source	2
2.2.6.1 Standard Audio Integral Signal Source	2
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2.2.11 Standard Deviation Monitor	3
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Excerpt from Factory Mutual Research Intrinsic Safety Standard

Approval Standard - Intrinsically Safety Apparatus
and Associated Apparatus for Use in Class I, II and III
Division 1, Hazardous Locations

APPROVAL STANDARD
INTRINSICALLY SAFE APPARATUS
AND
ASSOCIATED APPARATUS
FOR
USE IN CLASS I, II AND III
DIVISION 1, HAZARDOUS LOCATIONS

CLASS NUMBER 3610

OCTOBER 1979



Factory Mutual Research

1151 Boston-Providence Turnpike
Norwood Massachusetts 02062

HOW TO APPLY FOR INTRINSIC SAFE EXAMINATIONS

Send a letter requesting an examination addressed to:

Instrumentation Section Manager
Factory Mutual Research Corporation
1151 Boston-Providence Turnpike
Norwood, Massachusetts 02062

The letter should indicate the Class(s), Division(s) and Group(s) for the hazardous locations you wish the examination to cover.

One copy of the following documentation should be submitted, logically organized and neatly assembled into an indexed bound package.

- (a) A complete list of all models and options by Class, Division and Group.
- (b) A list of major or specific use application of the equipment.
- (c) A system block diagram showing the location (i.e., hazardous or non-hazardous location) and inter-connection of equipment.
- (d) Installation, operation, and maintenance instructions.
- (e) Circuit physical layout drawing(s), schematic(s), and parts list(s).
- (f) Assembly drawings showing overall physical separation of safe and unsafe circuits if not shown in circuit layout drawing.
- (g) Drawings, specifications, and source control information for all protective components.
- (h) Quality control documentation, and test procedures for all protective components and assemblies.
- (i) Drawing(s) showing proposed labels to be applied to final product(s).
- (j) If available, test report(s) by internationally recognized testing laboratories (e.g., CSA, PTB, BASEEFA).

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Factory Mutual Research

1151 Boston-Providence Turnpike
Norwood, Massachusetts 02062

Class No. 3610
October 1979

APPROVAL STANDARD

INTRINSICALLY SAFE APPARATUS

AND

ASSOCIATED APPARATUS

FOR

USE IN CLASS I, II AND III

DIVISION 1, HAZARDOUS LOCATIONS

NOTICE: The asterisk following the subsection number signifies that explanatory material on that paragraph appears in Appendix A.

I INTRODUCTION

1.1 This standard serves as the basis for Factory Mutual approval of intrinsically safe apparatus and associated apparatus. This standard provides requirements for the construction and testing of electrical apparatus, or parts of such apparatus, whose circuits are incapable of causing ignition in Division 1 hazardous locations as defined in Article 500 of the National Electrical Code, NFPA-70.

1.2 Intrinsically safe apparatus and associated apparatus (including wiring) is apparatus in which any spark or thermal effect, produced either normally or in specified fault conditions, is incapable, under the test conditions prescribed in this standard, of causing ignition of a specified mixture of flammable or combustible material in air.

1.3 Factory Mutual approval is based on satisfactory evaluation of the product and manufacturer in the following major areas:

1.3.1 Examination and tests to evaluate: (1) the suitability of the product; (2) the operation and performance of the product as required by Factory Mutual and, as far as practical; (3) the durability and reliability of the product.

1.3.2 Periodic examination of the manufacturing facilities to evaluate: (1) the manufacturer's ability to produce the product as examined and approved; (2) the quality control procedures applied to the product; and (3) the marking procedures which shall be used to identify the product.

1.4 Continued approval is based upon: (1) production or availability of the product as currently approved; (2) the continued use of acceptable quality control procedures; and (3) satisfactory field experience.

1.5 The requirements of this standard identify Factory Mutual approval tests and practices. Devices which do not conform to these requirements may be approved if they meet the intent of this standard. Conversely, those that do conform may not be approved if other conditions prevail.

1.6 The construction, tests and marking required by this standard correspond, in general, to the National Fire Protection Association standard for Intrinsically Safe Apparatus and Associated Apparatus For Use In Class I, II and III, Division 1 Hazardous Locations, NFPA - 493 (1978)¹. NFPA-493 was the result of extensive committee activity and analysis, coupled closely with previous work done by the Instrument Society of America and the International Electrotechnical Commission.

¹Available from National Fire Protection Association, 470 Atlantic Ave., Boston, MA 02210

II SCOPE

2.1* APPLICATION

This standard shall apply to:

(1) Apparatus or parts of apparatus in Class I, II or III, Division 1 locations as defined by the National Electrical Code, NFPA-70.

Note: Section 500-2(a) of NFPA 70-1978, National Electrical Code, states that equipment approved for Division 1 locations shall be permitted in Division 2 locations of the same class and group.

(2) Associated apparatus located outside of the Class I, II or III, Division 1 location whose design and construction may influence the intrinsic safety of an electrical circuit within the Class I, II or III, Division 1 location.

2.2* REQUIREMENTS

These requirements are based on consideration of ignition in locations made hazardous by the presence of flammable or combustible material under normal atmospheric conditions.

2.2.1 For the purposes of this standard, normal atmospheric conditions are considered to be:

- (1) An ambient temperature of 40°C (104°F);
- (2) An oxygen concentration not greater than 21 percent; and
- (3) A pressure of one atmosphere.

2.3 MECHANISMS OF IGNITION

2.3.1 This standard does not cover mechanisms of ignition from external sources such as static electricity or lightning, which are not related to the electrical characteristics of the apparatus. However, the possibility of static charge on polymeric materials and ungrounded metal parts shall be considered during the approval examination.

2.3.2 This standard does not cover apparatus based on high voltage electrostatic principles (i.e., electrostatic paint spraying).

2.4 APPLICABILITY OF OTHER STANDARDS

2.4.1 Except where modified by the requirements of this standard, intrinsically safe and associated apparatus shall comply with the applicable requirements for ordinary locations, in accordance with FM Approval Standard 3820.¹

¹As another example of requirements for ordinary locations, see ANSI C39.5 Safety Requirements for Electrical And Electronic Measuring and Controlling Instrumentation, available from the American National Standards Institute, 1430 Broadway, New York, NY 10018

Exception: Circuits operating below extra-low voltage or limited-power are not included in the scope of FM Approval Standard 3820. Extra-low and limited-power circuits are defined as:

Extra-Low Voltage Circuit

An extra-low voltage circuit is one in which the maximum voltage measured between the conductor or part in question and its associated circuit common is not more than 30 V rms (sine wave) or 60 V dc.

Limited-Power Circuit

A limited-power circuit is one in which the maximum power available from the circuit does not exceed 150 watts as measured by a watt meter and an external test resistor connected in parallel to the circuit load after one minute.

2.4.1.1 Intrinsically Safe Apparatus or Associated Apparatus which have one or more circuits operating above and below the specified levels for extra-low voltage or limited power circuits are subject to the requirements of FM Standard 3820 from two aspects. In these cases, the requirements are applicable only to the circuits or parts of a circuit that exceed the specified levels and between those that do and those that do not exceed the specified levels. This is to assure that the required degree of protection against electrical shock and fire is provided where necessary and that the inherent protection afforded by the below limit circuits is not compromised. This concept also applies to equipment or accessories rated for connection to other circuits for measuring purposes, etc. and exceeding the specified levels for extra-low voltage and limited power circuits.

2.4.1.2 Whether circuits are extra-low voltage or power limited is determined by measurement.

2.4.2 Associated apparatus and circuits shall¹ conform to the requirements of the location in which they are installed.

¹For guidance on installation, see ANSI/ISA RP12.6, Installation of Intrinsically Safe Instrument Systems in Class I Hazardous Locations, available from the Instrument Society of America, 400 Stanwix St., Pittsburgh, PA 15222.

III DEFINITIONS

3.1 ASSOCIATED APPARATUS

Apparatus in which the circuits are not necessarily intrinsically safe, but which affect the energy in the intrinsically safe circuits and are relied upon to maintain intrinsic safety.

3.2 CLEARANCE DISTANCE

The shortest distance measured in air between conductive parts.

3.3 CREEPAGE DISTANCE

The shortest distance measured over the surface of insulation between conductive parts. Air gaps less than 0.04 in. (1 mm) are not considered to interrupt the surface.

3.4 FAULT

A defect or electrical breakdown of any component, spacing, or insulation which alone or in combination with other faults may adversely affect the electrical or thermal characteristics of the intrinsically safe circuit. If a defect or breakdown leads to defects or breakdowns in other components, the primary and subsequent defects and breakdowns are considered to be a single fault.

3.5 FUSE PROTECTED SHUNT DIODE BARRIER ASSEMBLY

See definition under protective component or assembly.

3.6 FUSIBLE-RESISTOR PROTECTED SHUNT DIODE BARRIER

See definition under protective component or assembly.

3.7 INTERNAL WIRING

Wiring and electrical connections that are made within the apparatus by the manufacturer. Within racks or panels, interconnections between separate pieces of apparatus made in accordance with detailed instructions from the apparatus' manufacturer are considered to be internal wiring.

3.8 INTRINSICALLY SAFE APPARATUS

Apparatus in which any spark or thermal effect, produced either normally or in specified fault conditions, is incapable, under the test conditions prescribed in this standard, of causing ignition of a specified mixture of flammable or combustible material in air. This apparatus is suitable for use in Division 1 locations.

3.9 INTRINSICALLY SAFE CIRCUIT

A circuit in which any spark or thermal effect, produced either normally or in specified fault conditions, is incapable, under the test conditions prescribed in this standard, of causing ignition of a specified mixture of flammable or combustible material in air.

3.10 NORMAL OPERATION

Intrinsically safe apparatus or associated apparatus conforming electrically and mechanically with its design specification.

3.11 PROTECTIVE COMPONENT OR ASSEMBLY

A component or assembly which is so unlikely to become defective in a manner that will lower the intrinsic safety of the circuit it may be considered not subject to fault when analysis or tests for intrinsic safety are made.

3.11.1 Shunt Diode Barrier Assembly

A fuse or resistor protected diode barrier.

3.11.2 Fuse Protected Shunt Diode Barrier Assembly

A network consisting of a fuse, voltage limiting shunt diodes and a current limiting resistor designed to limit current and voltage. The fuse protects the diodes from open circuiting when high fault current flows.

3.11.3 Resistor Protected Shunt Diode Barrier Assembly

A network that is similar to a fuse protected shunt diode barrier with the exception that the fuse is replaced by a resistor.

3.11.4 Fusible-Resistor Protected Shunt Diode Barrier Assembly

A network that is similar to a fuse protected shunt diode barrier with the exception that the fuse is replaced by a fusible-resistor.

3.12 RESISTOR PROTECTED SHUNT DIODE BARRIER ASSEMBLY

See definition under protective component or assembly.

3.13 SHUNT DIODE BARRIER ASSEMBLY

See definition under protective component or assembly.

3.14 SUPPLY VOLTAGE

The nominal operating voltage applied by an external source to the apparatus or associated apparatus.

IV EVALUATION OF INTRINSIC SAFETY

4.1 FUNDAMENTAL REQUIREMENTS

4.1.1* Intrinsically safe apparatus, associated apparatus and circuits shall meet the two basic requirements specified in 4.1.2 and 4.2. Intrinsically safe apparatus with frequently operating contacts in parts of the apparatus likely to be exposed continuously or for long periods to a flammable atmosphere should have such contacts provided with supplementary protective measures.

Examples of supplementary protective measures:

- (a) Hermetically sealed enclosures of quality obtained by fusing glass;
- (b) Protection by an explosion-proof enclosure;
- (c) Doubling of the factors applied on energy.

4.1.2 The energy available in the hazardous location shall not be capable of igniting the hazardous atmospheric mixture specified in Appendix C2 due to arcing or temperature during normal operation or under fault conditions.

4.2 NORMAL OPERATION

4.2.1 Normal operation shall include all of the following:

(a) Supply voltage at maximum value. This maximum voltage to be applied for normal operation tests shall be 1.1 times the manufacturer's specified nominal voltage for which the equipment has been designed.

Note: Due to international interests of manufacturers and at their specific request Factory Mutual will examine equipment at 1.15 times the manufacturer's specified nominal voltage.

(b) Environmental conditions within the ratings given for the apparatus or associated apparatus;
(c) Tolerances of all components in the combination that represents the most unfavorable condition;
(d) Adjustments at the most unfavorable settings;
(e) Opening, shorting, and grounding of the field wiring of the intrinsically safe circuit being evaluated.

Note: Opening means a complete separation of all strands of the wiring.

4.2.2* Normal operation shall include an additional factor for test purposes of 1.5 on energy. Such factors shall be achieved according to the procedures outlined in Section 13.2. Before faults are introduced the apparatus shall be in normal operation as specified in Section 4.2.

Note: Factors given in this standard differ from those published in the Canadian and CENELEC standards. This standard bases the 1.5 factor on energy while other standards base the 1.5 factor on current or voltage, which may result in a 2.25 factor on energy. Due to international interests of manufacturers and at their specific request Factory Mutual will examine equipment using the 1.5 factor on current or voltage.

4.3 FAULT CONDITIONS

4.3.1 Fault conditions shall include the following:

- (a) The most unfavorable single fault and any subsequent related faults, with an additional factor of 1.5 applied to energy;
- (b) The most unfavorable combination of two faults and any subsequently related faults, with no additional factor.

Such factors shall be achieved according to the procedures outlined in Section 13.2.

APPENDIX C

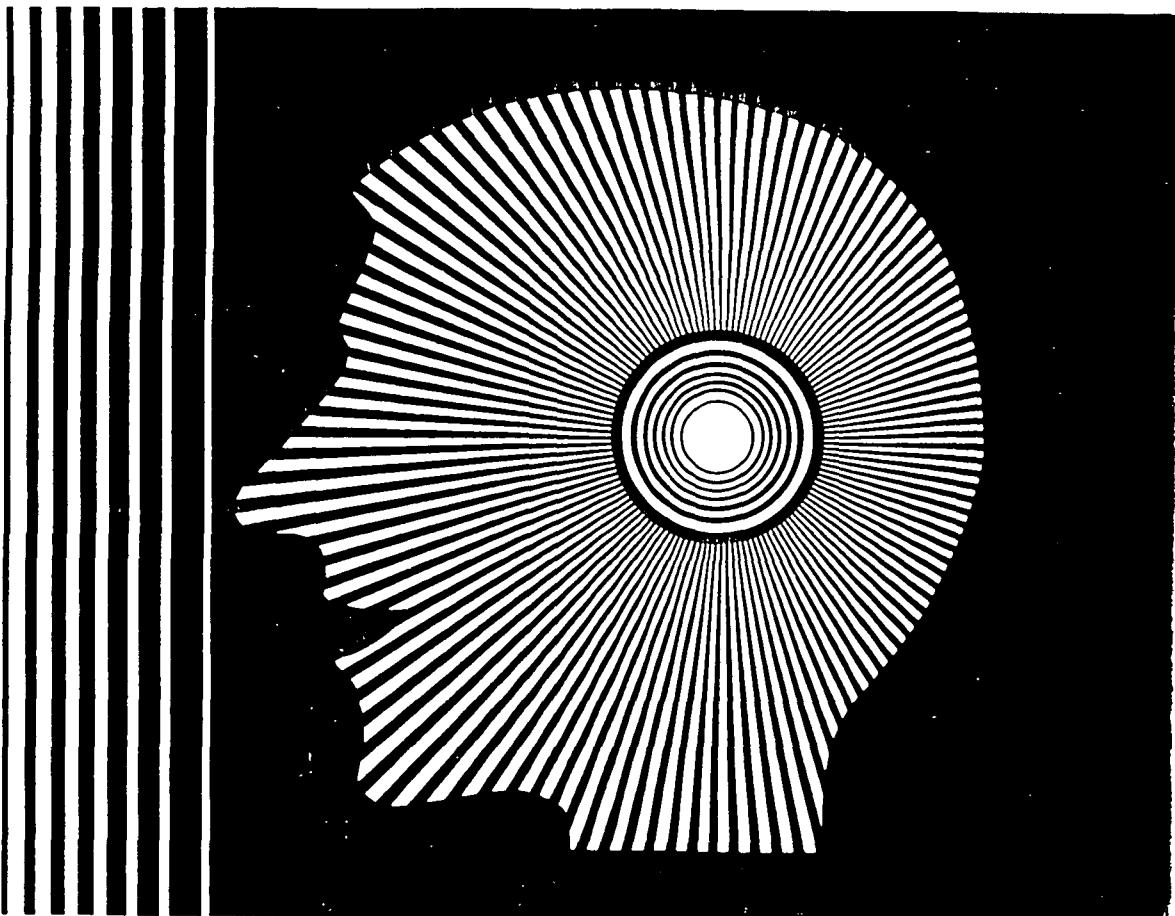
Currently Available Ear Microphone Products

TAD EARMIC

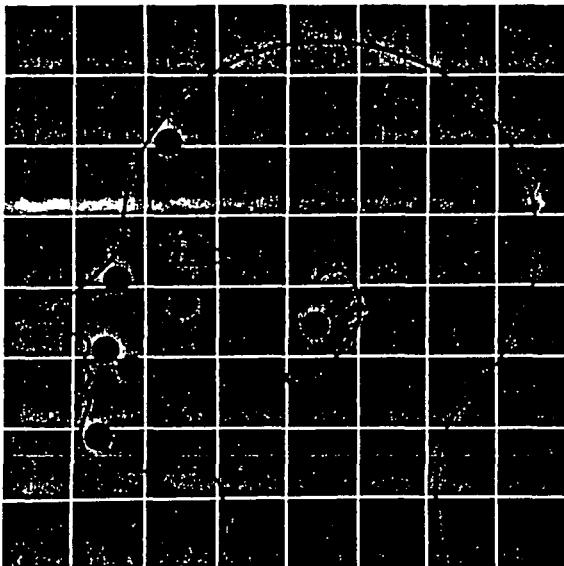
EAR MICROPHONE SYSTEM

JUST WHISPER TO SPEAK WITH HIM MILES AWAY TAD EARMIC IS A UNIQUE 2 WAY COMMUNICATION DEVICE TO TALK AND LISTEN THROUGH YOUR EAR. IT PERMITS HAND-FREE OPERATION IN HIGH NOISE ENVIRONMENTS

COUPLED WITH TOUGH-LINE TAD RADIOS, THE EAR-MIC ALLOWS YOU TO OPERATE YOUR FIELD COMMUNICATIONS UNDER SEVERE ENVIRONMENTAL CONDITIONS, INCLUDING EXTREME HIGH NOISE LEVELS, ABNORMAL TEMPERATURES VIBRATION AND SHOCK.

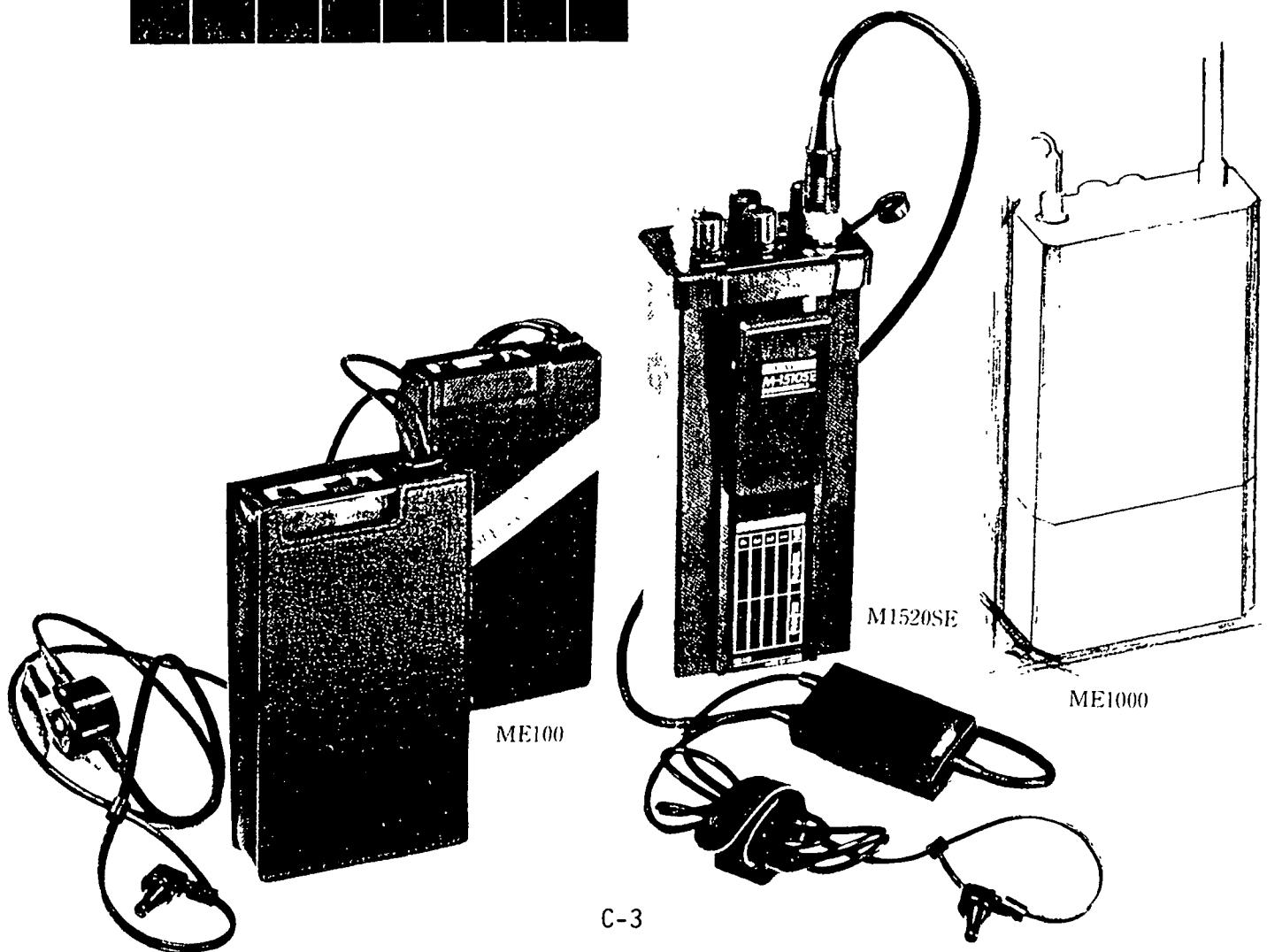


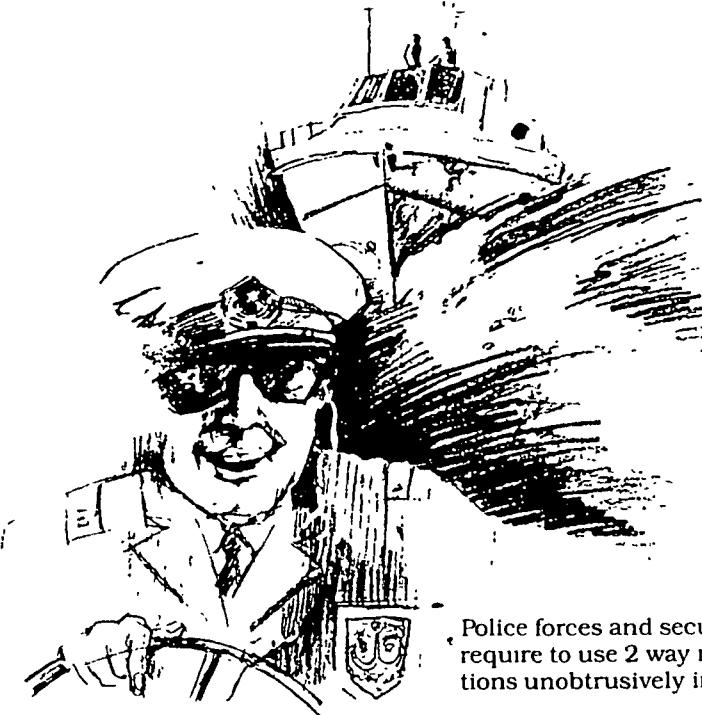
CHOICE OF THE PROFESSIONALS



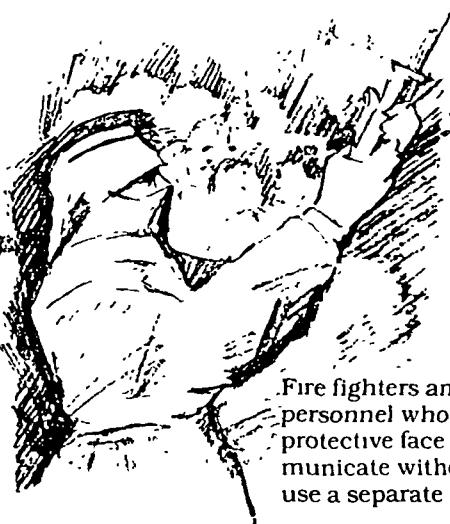
THE TAD EAR-MIC HAS BEEN SPECIALLY DESIGNED TO PROVIDE CLEAR SPEECH COMMUNICATIONS BY MEANS OF BONE-CONDUCTION. OUR BONE CONSTRUCTION OF THE HUMAN HEAD IS SUCH THAT VIBRATIONS OCCUR WHEN WE SPEAK THROUGH VARIOUS RESONANT POINTS

FOR CONVENIENCE, IT IS POSSIBLE TO USE A SINGLE TRANSDUCER FITTED IN THE EAR TO PROVIDE BY TRANSMISSION AND RECEPTION OF SPEECH MESSAGES.





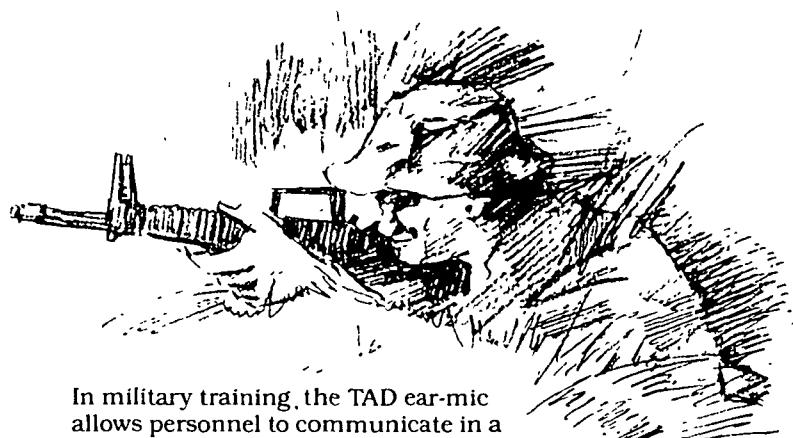
Police forces and security services often require to use 2 way radio communications unobtrusively in crowded areas.



Fire fighters and other rescue personnel who need to wear protective face masks can communicate without the need to use a separate microphone.



Radio operation within construction sites can be performed easily and efficiently even in high noise areas.



In military training, the TAD ear-mic allows personnel to communicate in a whisper with hands-free operation.

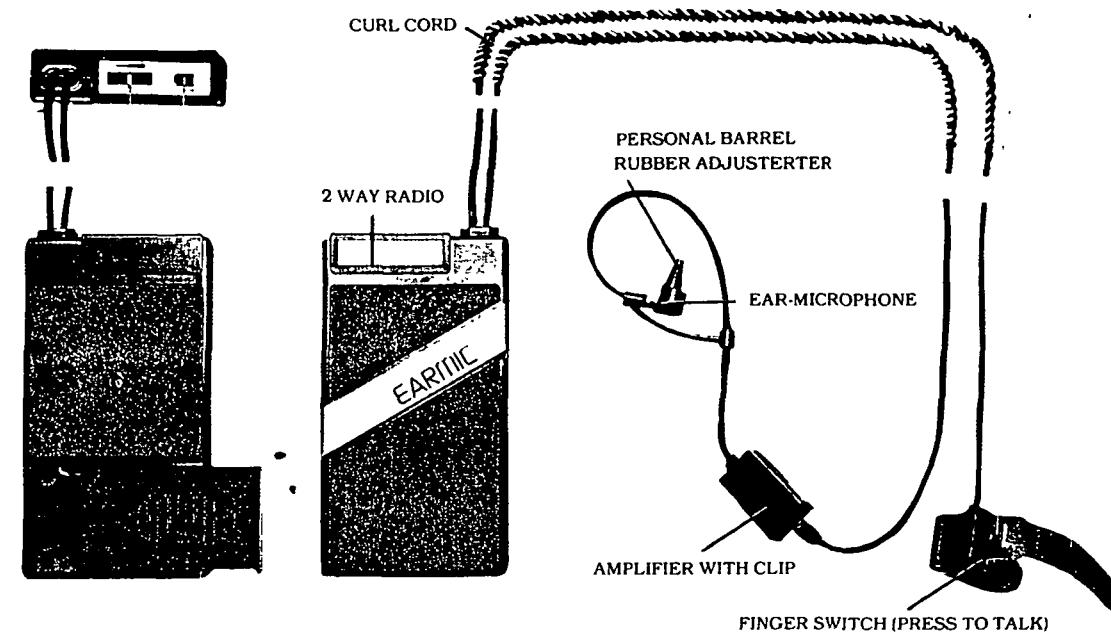


Operators of noisy machinery in factories have no difficulty in conversing with each other by using ear-mic



Forestry and mining industry find the ear-mic beneficial in overcoming dangerous situations which can cause serious injuries due to the inability to communicate in noisy environments.

DESCRIPTIONS OF PARTS

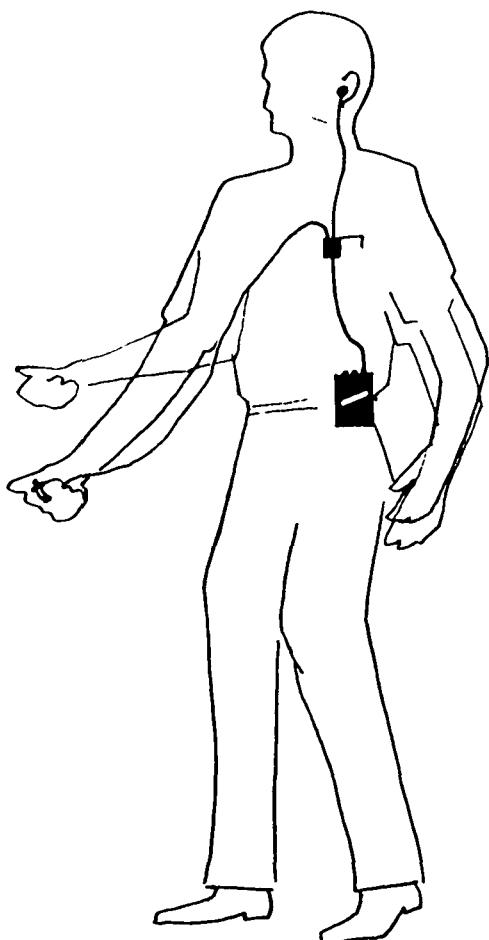


SPECIFICATIONS

Pocket Size Medium Duty	Pocket Size Heavy Duty Water Resistant Crush Proof	FCC/DOC Pending Accepted Extra Heavy Duty Water Proof Intrinsically Safe Crush Proof
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Model ME100 ME1000 M1520SE

Frequency Range	150MHz	VHF/UHF	VHF/UHF
RF Output	100mW	up to 3W	up to 5W
Number of Channel	1	up to 4	up to 6
Power Supply	2.4VDC	7.2/9.6VDC	12.0VDC
Rechargeable Nicad Battery Pack			
Operation	Press to talk Simplex or Sem Duplex		
Ambient Temperature	-10 ~ +50	-30 ~ +60	-30 ~ +60
Ambient Noise Level	Satisfactory communication under 100 Horn (130 Horn with Ear Cover Pad)		
Dimensions (W x D x H)	75 x 23 x 135mm (3 x 7/8 x 5-1/2in)	70 x 37 x 125mm (3 3/4 x 1 1/2 x 5in)	72 x 52 x 184mm (2 7/8 x 2 x 6 1/4in)
Weight	260g (10oz)	400g (15oz)	780 (29oz)



TAD COMPACT
COMMUNICATIONS
TAD AMERICA CORPORATION

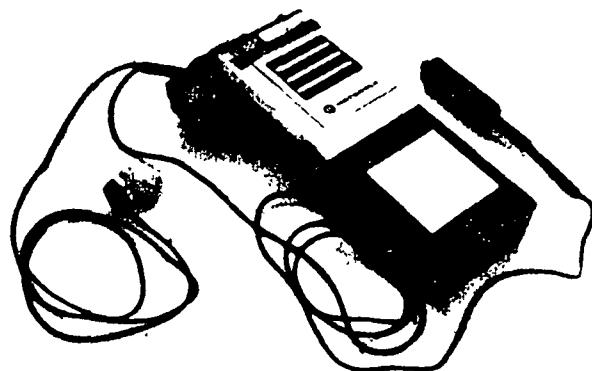
HAWAII MAIN OFFICE
686 Ahua Street, Honolulu, Hawaii 96819
(808) 873-5185 Telex 395 127 TADAM
TOLL FREE INFORMATION ORDERING 800/367-2602

TAD COMPACT
COMMUNICATIONS
TAD CORPORATION

Garden Courts
221-4 Shoten Shibusawa-ku, Tokyo 150
Telex 0242-3245
Telephone 03-3211-4850 Fax 03-3211-4851

NEW — PRODUCT — RELEASE

KAQ-COM - A new technology concept that permits you to transmit and receive through your ear.



KAQ-COM permits clear voice transmission to be sent and received through the earpiece. The transducer mounted in the ear picks up sound energy through the otolarynx canal as the user is talking. These sounds are fed into an interface amplifier module which is an integral part of the KAQ-COM unit. They are then transmitted through the users radio.

Custom molded to the individual users own ear, the earpiece snaps on or off of the KAQ-COM transducer module. This allows anyone with their own earpiece extensive flexibility and mobility when using the dynamic new KAQ-COM.

The system can be installed in virtually any VHF, UHF, or HF radio and when disconnected from the radio, returns to it's former normal operating mode and capability



KAQ-COM'S ear to radio interface picks up minute sound energies from the otolarynx canal as the person talks. These are amplified through a control module and transmitted through the user's radio.

KAVCO Industries Inc.

Sales Office: 416 East Alondra Blvd. • Gardena, CA 90248 • (818) 782-2902
Corporate Office: (213) 324-2401

KAV-COM

HISTORY

While the concept of throat and ear type microphones is not new, the constant problem associated with each, that of interference from outside ambient noises with the basic voice range frequencies was totally unacceptable and thus the concept was virtually discarded.

The concept of a molded earpiece to reduce ambient noise has been used successfully and was accepted as commonplace as well

However, the idea of plugging up the outside ear in combination with providing a miniature implanted transducer unit, capable of both transmitting and listening at different intervals was the real challenge

That challenge has been met and perfected by KAVCO Industries of Gardena, California with the introduction of their new KAV-COM modular ear adapter transceiver communications module

BASIC COMPONENTS

1. Earpiece - custom molded from an actual cast of the user's own ear to assure complete comfort during long hours of use as well as blocking out all unwanted ambient outside noises thus assuring quality audio reception and voice transmission unequalled by any system available to date

2. Transducer - completely self contained micro system designed to mate instantly with the above earpiece providing all necessary electronic interface between the configurations of the user's own ear and the basic two way hand held or pocket carried light-weight modern radio system.

3. Connector - unit provided to interface transducer wiring to actual radio unit. This may be a side screw type fastener adapter or the more common plug in type unit.

4. Amp-Mod Unit - this is the nerve/capsulated main control system of the KAV-COM success story. This mini/micro system, when connected to the selected hand held radio enables that radio to function in every normal mode without the KAV-COM attached, and yet, by simply attaching the KAV-COM unit to the same radio function as an entirely new concept of ultra-light, hands free, non-cumbersome communications system

APPLICATIONS

Firefighters: If free flow airpack eliminates the mask mike, KAV-COM is now able to take up the slack. KAV-COM allows you to talk and listen independent of any other equipment being worn

Law Enforcement (immigration, military, commercial uses of all types conceivable): Foot patrol - no identifiable transmissions or loud audio to disclose position. Normal voice audio when transmitting. Suspect interrogation - with non-obvious push-to-talk switch. All conversations transmitted and recorded if desired. ONA calls pre-empted when necessary

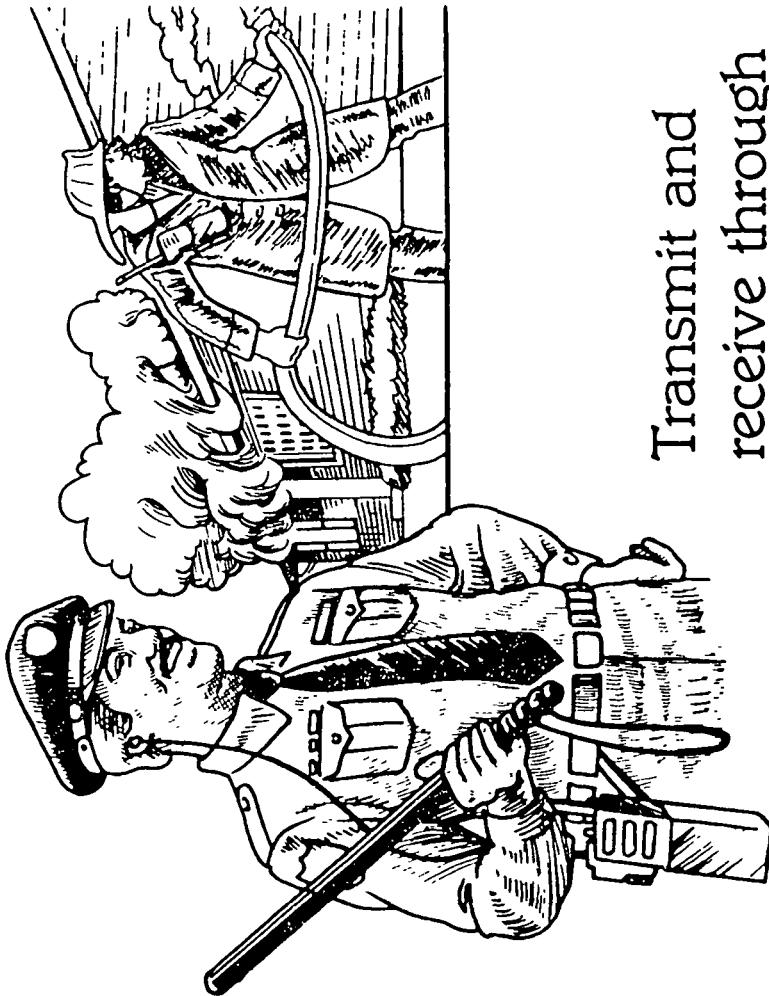
Undercover - worn inconspicuously in the ear with a cord running down to radio. When supplied with under arm or sleeve cord push-to-talk switch communications can be completed with minimum interference with other essential activities

Motorcycle officers - being totally independent of vehicle enables user to dismount and pursue on foot without interruption of vital communications link.

Paramedic/Fire Jumpers, Etc. (aviation, commercial uses): Stability and function of your communications system even when worn under crash helmet is unsurpassed. It assures continual communications even during a normally disabling landing

KavCom

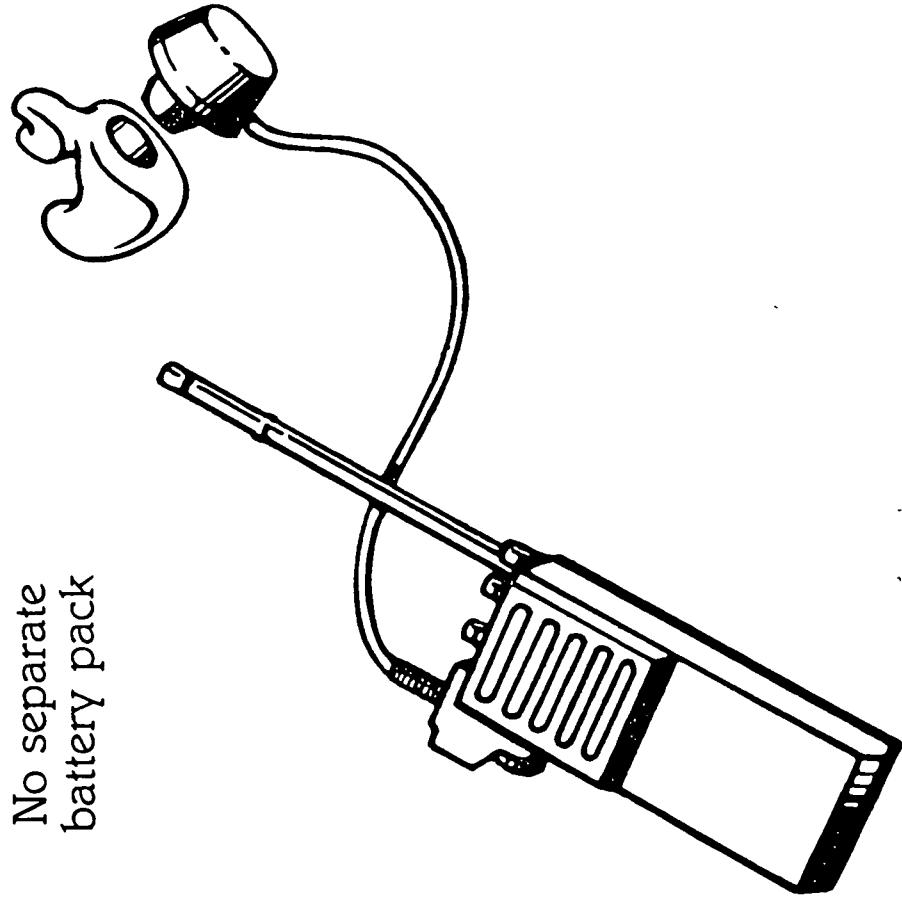
A NEW CONCEPT IN HANDS FREE VOICE COMMUNICATIONS



Transmit and
receive through
your ear.

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No separate battery pack

TravCom allows clear voice transmission to be sent and received through the same earpiece. The transducer picks up minute sound energies from the otolarynx canal as the person speaks. These are amplified and transmitted through the user's radio.

The system can be installed in virtually any VHF, UHF, or HF radio. When disconnected, the radio returns to its normal operating mode.

• EARPIECE

Custom molded from an actual cast of the user's ear. Assures complete comfort during long hours of use. Blocks out all unwanted ambient noises and assures unequalled audio reception and voice transmission.

• TRANSDUCER

Completely self-contained micro system designed to mate with the earpiece. Provides all necessary electronic interface between the user's ear and the two way hand held or pocket carried radio.

• CONNECTOR

Interfaces transducer wiring to the radio. May be a side screw type fastener adapter or the more common plug-in type unit.

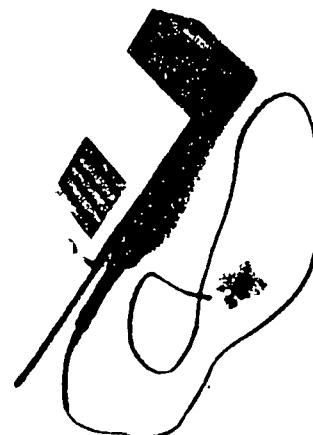
• EXTENDED PUSH-TO-TALK SWITCH

Cord running down the arm attached to a hand switch allows hands free transmission.

Custom designed transmitting switches available upon request.

FEATURES

- Hands free operation with extended push-to-talk switch
- Custom molded earpiece snaps on & off—Multiple personnel can use same radio
- No feedback when units are close together
- No interference with breathing apparatus
- Radio can be used in normal mode if desired
- No separate battery pack required
- Transmits audio levels as low as a whisper
- Blocks out outside noise while receiving and transmitting
- No extra box full of electronics



APPLICATIONS

- **FIREFIGHTERS**

When the free flow airpack eliminated the mask mike, **KavCom** was there to take up the slack... Speak or listen independently of any other equipment being worn.

- **LAW ENFORCEMENT:**

Police, Border Patrol, FBI, Secret Service, etc.

Foot Patrol - No identifiable transmissions or loud audio to disclose position. Normal voice audio when transmitting. Suspect interrogation with non-obvious push-to-talk switch. All conversations transmitted and recorded if desired.

Undercover - Worn inconspicuously in the ear with a cord running down to the radio. When supplied with under arm or sleeve cord push-to-talk switch communications can be completed with minimum interference with other essential activities.

Motorcycle Officers - Being totally independent of vehicle's radio enables user to dismount and pursue on foot without interruption of vital communications link.

- **PARAMEDICS/FIRE JUMPERS, ETC:**

Stability of system when worn under crash helmet is unsurpassed. Thus assuring continual communications even during landing, which would normally cause the system to malfunction due to shock or physical contact.

- **OTHER APPLICATIONS:**

Construction, Mining, Logging, Building Security, Airline Gate Agents, Ramp Operations or Military. Applies anywhere that 2-way voice with hands free or totally discreet communication is required. The unit is extremely valuable in a high noise environment since it muffles all outside noises.

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APPENDIX D

Study Contacts

A number of individuals and organizations provided material, insights, and recommendations that have been incorporated into this Firefighters Communication System Operational Test Plan. Among the contributing sources are:

Electronic Industries Association

Pete Bennett, Staff Vice-President
Washington, DC

Factory Mutual Research

Robert L. Martell, Jr., Manager, Instrumentation Section
Norwood, MA

Federal Communications Commission

Frank Coperich, Electrical Engineer
Columbia, MD

National Aeronautics and Space Administration

Joseph L. Bell, Electrical Engineer
NASA Marshall Space Flight Center
Huntsville, AL

National Institute of Occupational Safety and Health

John Etherton, Explosive Atmospheres Specialist
Morgantown, WV

United States Coast Guard

Lt. S. Phil Glenn, Response Officer
Mr. Lundburg, Strike Team Member
Mr. Perkins, Strike Team Member
Mr. Snyder, Strike Team Member
National Strike Force
Atlantic Strike Team
Elizabeth City, NC

Lt. JG Jeff Stull, R&D Officer Headquarters
Washington, DC

United States Fire Administration

Mr. Tom Smith
National Emergency Training Center
Emmitsburg, MD